

Measurement and Analysis for ISD Projects

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Title: Measurement and Analysis for ISD Projects

Asset Type: Process

PAL Number: 3.4

Purpose

This purpose of this process is to develop and sustain the measurement capabilities necessary to support the information needs of ISD projects.

Scope

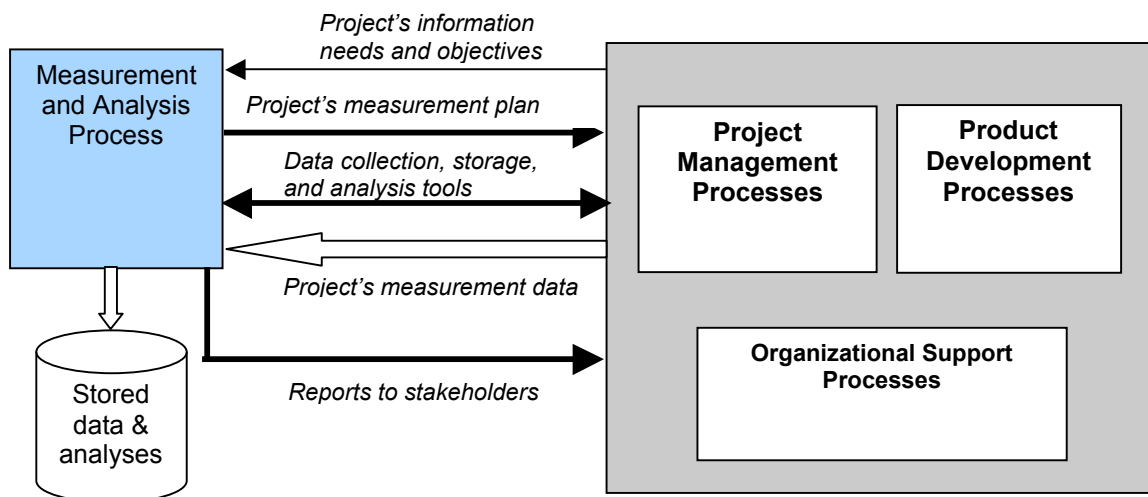
Although this process may be used on all ISD projects, it is mandatory for [Class A, B and C](#) software projects. It should also be used by other ISD projects that are required to complete the ISD Data Collection Spreadsheet (i.e., those projects with effort estimated at five staff years or more).

Additional requirements for measurement and analysis in the Flight Software Branch (FSB) are documented in the [“FSB Measurement, Analysis, and Reporting Standard.”](#)

***GUIDANCE:** ISD also conducts measurement and analysis for its organizational measurement program. This program, which creates planning models for future projects, analyzes productivity and quality trends, and assesses the effectiveness of process improvement efforts at the Division level, is described on the [“ISD Measurement Program”](#) page of the SPI website.*

Context Diagram

Measurement and Analysis Context



Roles and Responsibilities**Product Development Lead (PDL)/ Maintenance Team Lead (MTL):**

- Develops and maintains the measurement plan, usually as part of the project's Software Management Plan/Product Plan (SMP/PP).
- Is responsible for the control, evaluation, and approval of measurement activities for the project
- Uses measures and measurement analyses to manage the project

Product Development Team (PDT)/Product Maintenance Team (PMT)

- Follows the project's established measurement plan
- Provides measurement data to the Measurement Team and/or PDL/MTL

Measurement Team

- May be formed at the Branch or project level to provide support to projects in collecting, storing, and analyzing measurement data and providing analysis reports
- Branch-level Measurement Teams may perform cross-project analyses to improve Branch-level processes.
- Receives support from the ISD Measurement Team

GUIDANCE: On small projects, the role of the Measurement Team may be performed by the PDL/MTL or a single designee from the PDT/PMT.

Measurement Team Representative (Rep)

- If a Branch-level Measurement Team exists, each project within the Branch is assigned a Measurement Team Rep.
- The Measurement Team Rep works with the PDL and PDT to set up data collection, storage, and reporting procedures and to collect and analyze the measurement data.

ISD Measurement Team

- Operates under the auspices of the GSFC Engineering Process Group (EPG)
- Provides measurement and analysis support to projects and Branch- or project-level Measurement Teams
- Collects and analyzes organizational data to support ISD objectives as specified by the ISD Measurement Program
- Provides organizational data to Center and Agency measurement programs

ISD Division Chief, Branch Heads, and Mission Project Managers

- May approve the projects' measurement plans
- May be stakeholders for this process

Usage Scenarios

Initial Usage Scenario: The PDL/MTL uses this process to prepare the measurement plan during initial project planning.

Re-entry Scenario: The PDL/MTL invokes this process whenever a project must be re-planned.

Continuous Usage Scenario: Tasks 6 through 9 of this process are performed iteratively throughout a project's life. They provide critical input to the [Project Monitoring and Control](#) process.

Inputs

- Project's information needs and objectives
- Commercial off-the-shelf (COTS) or government-off-the-shelf (GOTS) tools for data collection, storage, and analysis
- Project's measurement data

Entry Criteria

- The [Project Planning](#) process has started.

Exit Criteria

- The [Project Closeout](#) process has been initiated.

Outputs

- Project's measurement plan
- Tailored or new tools for data collection, storage, and analysis
- Stored measurement data and analyses
- Reports to stakeholders

Major Tasks

This process consists of nine major tasks. Although Tasks 1 through 5 may be performed sequentially during project planning and startup, it is more common to iterate through these Tasks until measurement planning is finalized. Tasks 6 through 9 are executed iteratively during product development and/or maintenance.

1. Establish measurement objectives. *(PDL/MTL)*
2. Identify the essential measurement analyses that support these objectives. *(PDL/MTL)*
3. Specify the measures to be collected. *(PDL/MTL)*
4. Specify data collection and storage procedures. *(PDT/PMT and Measurement Team Rep.)*
5. Specify analysis procedures. *(PDL/MTL and Measurement Team Rep.)*
6. Collect measurement data. *(PDL/MTL and/or Measurement Team Rep.)*
7. Analyze collected data. *(PDL/MTL and/or Measurement Team Rep.)*
8. Store collected data and analysis results *(PDL/MTL and/or Measurement Team Rep.)*
9. Communicate results to stakeholders *(PDL/MTL)*

GUIDANCE: See the "Measurement for Projects" page of the [GSFC Software Process Improvement \(SPI\) website](#) for additional help in setting up measurement on a software project.

Task 1

Establish measurement objectives. (PDL/MTL)

GUIDANCE: Measurement objectives document the reasons why measurement and analysis are performed. The sources for measurement objectives may be management, technical, project, product, or process implementation needs, such as:

1. *Achieve completion by scheduled date*
2. *Complete the project within budget*
3. *Devote adequate resources to each process area.*

Corresponding measurement objectives for these needs might be:

1. *Measure project progress to ensure it is adequate to achieve completion by scheduled date*
2. *Track cost and effort to ensure project completion within budget*
3. *Measure the resources devoted to each process area.*

A key source for information needs and objectives on ISD projects is the cost and schedule estimate and accompanying "basis of estimate." Additional sources include: strategic plans, high-level requirements, operations concepts, and draft SMP/PP.

GUIDANCE: NPR 7150.2 levies requirements for measurement on NASA projects. Accordingly, ISD has established a standard set of measurement objectives and measures that satisfy these requirements as well as those of the Software Engineering Institute's "Capability Maturity Model® Integration (CMMI)". This "standard measures summary" is available via the ["Measurement for Projects"](#) page of the GSFC SPI Website. For the Flight Software Branch, the ["FSB Measurement, Analysis, and Reporting Standard"](#) identifies specific measurement objectives, measures, and data collection & analysis procedures for flight software projects. It includes a "Standard Measures Template" that can be tailored for inclusion within a flight software project's measurement plan.

- a) Document the information needs and objectives that have priority for this project.
- b) Use the ["standard measures summary"](#) or, for flight software (FSW) projects, the ["FSB Measurement, Analysis, and Reporting Standard"](#) to help identify measurement objectives for each of these needs.
- c) Document these measurement objectives in the project's measurement plan, maintaining clear traceability from the project's information needs and objectives.

GUIDANCE: Although the project's measurement plan is usually included within the Software Management Plan/Product Plan (SMP/PP), a project may choose to maintain it as a separate document.

Templates for the SMP/PP for Class B&C Projects and the SMP/PP for Class D&E Projects are available from the [GSFC Process Asset Library](#) (PAL). The FSB has a tailored "Flight Software Product Plan Template," which is also available in the PAL.

Task 2

Identify the essential measurement analyses that support these objectives. (PDL/MTL)

- a) Use the “[standard measures summary](#)” or, for FSW projects, the “[FSB Measurement, Analysis, and Reporting Standard](#)” to identify candidate analyses that could provide the information identified in Task 1.
- b) If multiple ways of analyzing information exist, prioritize candidates and select the essential, key analysis (or analyses) that will best satisfy the objective.
- c) Document the selected analyses in the measurement plan, maintaining traceability to measurement objectives and information needs.

GUIDANCE: Analysis can be as simple as comparing estimates to actuals over time.

Task 3

Specify the measures to be collected. (PDL/MTL)

- a) Using the ISD “[standard measures summary](#)” or “[FSB Measurement, Analysis, and Reporting Standard](#),” determine what measures are needed in order to be able to perform the analyses identified in Task 2.
- b) For measures not specified in the ISD or FSB standard, define the new measure by name, category, and unit of measure.
- c) In the measurement plan, document each of the identified measures, maintaining traceability to the objectives and analyses identified in Tasks 1 and 2.

GUIDANCE: The ISD and FSB standards specify the collection of both process and product measures. A common process measure is the effort expended in applying the process. If it is infeasible to collect effort separately for each process area individually, effort expended in several process areas may be grouped and collected together.

Task 4

Specify data collection and storage procedures. (*PDT/PMT and Measurement Team Rep.*)

GUIDANCE: When documenting new procedures, try to make them as simple as possible. Standardized collection and storage procedures for FSB are documented in the [“FSB Measurement, Analysis, and Reporting Standard.”](#) Detailed, tool-specific FSB procedures are documented within each data collection spreadsheet; see the [“Tools”](#) section of this process.

GUIDANCE: Take advantage of COTS and GOTS tools that can be used for data collection and storage, such as discrepancy and change reporting (DCR) systems, requirements management tools, and project management tools. Many of these tools can export data to spreadsheets and/or generate reports and graphs for use in status presentations.

Various data collection and storage tools have been developed or tailored specifically for use in ISD; see [“Tools.”](#)

- a) Determine whether or not collection mechanisms and/or sources for the measurement data specified in Task 3 already exist.
- b) Identify measures (from those specified in Task 3) that are not currently available and for which no collection mechanisms exist.
- c) Specify how to collect and store the data for each required measure. Identify the following:
 - Where will the measurement data be stored, i.e., in what measurement repository? *GUIDANCE: Measurement data repositories are listed in the data management plan within the SMP/PP.*
 - When will the data be collected? When stored?
 - Who will be responsible for obtaining the data?
 - Who will be responsible for data storage, retrieval, and security?
 - What data collection and/or storage tools will be used (e.g., spreadsheets, databases)?
- d) If the necessary data collection mechanisms do not exist, create or tailor appropriate data collection and storage tools. Use automatic collection of data when appropriate and feasible.
- e) Contact the ISD Measurement Team to discuss how and when ISD measures -- a subset of the project's measures -- will be submitted.
- f) Document all data collection and storage procedures to be used.
- g) Review the procedures with those responsible for providing, collecting, and/or storing data; update procedures as necessary.
- h) If execution of this Task has necessitated changes to the measurements to be collected or measurement objectives, repeat Tasks 2 and/or 3.

Task 5

Specify analysis and reporting procedures. (*PDL/MTL and Measurement Team Rep.*)

- a) Identify who will be responsible for analyzing the project's measures and who will report the analysis results.
- b) Determine how often analysis will be performed, and when and to whom the results will be presented and/or disseminated.
- c) Determine how the results will be presented (e.g., pie charts, bar charts, line graphs, tables) and in what venues (e.g., status meetings, milestone reviews).
- d) Identify any statistical methods to be used (e.g., regression analysis) and statistics to be presented (e.g., arithmetic mean/median/mode).
- e) Determine what analysis tools will be used.
- f) Identify how the resulting charts, graphs, or tables will be evaluated. Describe what result should trigger corrective action, e.g., an actual that is 10% above or below target. The corrective action may be as simple as raising a concern at a review or it may be more significant, such as adding staff or re-planning.
- g) Identify the repository where the analysis results and reports will be stored, when they will be stored, and who is responsible for their storage and maintenance.
- h) Document these determinations as analysis and reporting procedures.

GUIDANCE: The FSB has specified analysis and reporting procedures for all flight software projects in its ["FSB Measurement, Analysis, and Reporting Standard."](#)

Task 6

Collect measurement data. (*PDL/MTL and/or Measurement Team Rep.*)

- a) Using the data collection procedures specified in Task 4, obtain project measures from the PDT/PMT.
- b) Perform integrity checks on the data immediately after collection to ensure erroneous and missing data are promptly identified and corrected.
- c) Calculate derived measures, such as ratios or percentages.
- d) Use the [ISD Data Collection Spreadsheet](#) to forward organizational measures to the ISD Measurement Team.

Task 7

Analyze collected data. (*PDL/MTL and/or Measurement Team Rep.*)

- a) Conduct initial analysis of the data as specified in the measurement plan.
- b) If the analysis proves inconclusive or inadequate for purposes of evaluation, determine whether or not additional data collection is needed. If so, re-execute Tasks 6 and 7.
- c) Before disseminating results, review the analysis with key stakeholders.
- d) Prepare the analysis results and conclusions for presentation.
- e) If additional data collection was necessary (in Step b), update the measurement plan and data collection and analysis procedures to include the additional measures. (See Tasks 1 through 5.)

Task 8

Store measurement data, analysis results, and reports. *(PDL/MTL and/or Measurement Team Rep.)*

- a) Before storing the project measures collected, review them for completeness, accuracy, integrity, and currency.
- b) Utilize the storage procedures documented in Tasks 4 and 5 to store measurement data, analysis results, and measurement reports in a project- or Branch-level repository (or repositories).
- c) Include in the repository any information necessary to interpret the measures or assess them for reasonableness and applicability.

GUIDANCE: Mechanisms for storage of FSB measures, analysis, and reports are defined in the [“FSB Measurement, Analysis, and Reporting Standard.”](#)

Task 9

Communicate results to stakeholders. *(PDL/MTL)*

- a) Report the results of measurement analyses to relevant stakeholders on a timely basis, i.e., at milestone and status reviews per Task 5.
- b) Assist stakeholders in understanding the results of analysis. Provide background information and explanations to ensure that results can be interpreted correctly.

GUIDANCE: A stakeholder is any group or individual that is affected by or is in some way accountable for the outcome of an undertaking. Stakeholders may include project members, management, suppliers, customers, end users, and others.

Execution of this task is critical to [Project Monitoring and Control](#). Communication of the results of measurement analyses allows management to monitor the “health” of the project and take corrective action when needed.

GUIDANCE: For flight software projects, the [BSR Template](#) defines how measures are to be reported to line management. Typically, measures are reported graphically with a brief summary of the significance of the data to the project.

GUIDANCE: Certain measurement analyses must be presented at milestone as well as status reviews. See the GSFC [PAL](#) for checklists that specify the contents of both Mission Project and software project milestone reviews.

Measures

The following measures are recommended for use in analyzing the effectiveness of the Measurement and Analysis process:

- Effort expended on measurement and analysis (periodic)
- Schedule for performing measurement and analysis activities
- Planned and actual number of project measures stored each month
- Planned and actual number of measurement reports produced by the project each month

GUIDANCE: The FSB collects a tailored version of these measures in the [FSW Metrics Spreadsheet](#) as “Process Data.”

Tools and Templates

Name	Description
Standard measures summary	Provides a standard set of measures for ISD software projects, including analyses and sample objectives. Can be tailored for individual projects.
FSB Measurement, Analysis, and Reporting Standard	Contains a standard set of measurement objectives, measures, analyses and procedures for ISD flight software projects.
ISD Software Management Plan/Product Plan (SMP/PP) for Class B & C Software	The SMP/PP template for use on all ISD Class B & C software projects except FSW projects.
Flight Software Product Plan Template	The Product Plan template to be used on all ISD FSW projects
ISD Software Management Plan/Product Plan (SMP/PP) for Class D & E Software	The SMP/PP template for use on all ISD Class D & E software projects
ISD Point-Counting Spreadsheets	These spreadsheets support the monitoring of work packages that 1) have a moderate number of known tasks and 2) have task dependencies which are not a serious source of risk. The spreadsheets can display trend information to provide insight into progress including the ability to meet schedules. A User's Guide is also provided.
FSW Point Counting Spreadsheet	A tailored version of the ISD spreadsheet for projects within the FSB.
FSW Metrics Spreadsheet	A tailored spreadsheet for collection of certain measurement data from flight software projects.
FSW Status Spreadsheet	A tailored spreadsheet for the collection of status information from flight software projects.
FSW Staffing Spreadsheet	A spreadsheet for use in the FSB in collecting the number of staff on a project.
ISD Measurement Collection Spreadsheet	This tool provides a standard template for the collection of ISD-level measures from software projects. It provides three worksheets: one for software characteristics, one for milestone data, and one to provide additional notes about a project. The instructions include definitions for all the measures to be collected.

Training

Course Name	Description
Earned Value (Progress Tracking with Earned Value or Point Counting)	This course presents Earned Value strategies and methods for the first time user of the Excel-based workbook tool.
Awareness Briefings on Measurement	Slides from Software Engineering Discussion sessions on software measurement; available on-line
Software Metrics Selection	This tutorial presents a software measurement methodology that has been developed and tailored for NASA. The tutorial explains this methodology and the mechanics of using on NASA projects.
Implementing Goal-Driven Software Measurement	A two-day course sponsored by Headquarters
Foundations of Project Management	Provides instruction on the methodologies, techniques, terms and guidelines used to manage cost, schedules and technical aspects through the life cycle of a project
Software Project Management	A 5-day, residential, intermediate-level course that provides an overview of project management and associated topics, including earned value, risk management, and cost/schedule/technical performance monitoring. It also addresses topics such as COCOMO, SLIM, function points, size estimation, trend charts, software testing, software peer reviews, and software metrics.

Training availability can be checked at <http://software.gsfc.nasa.gov/training.cfm>.

References

This process is consistent with the following policies and standards.

- **NPR 7150.2**, NASA Software Engineering Requirements
- **GPG 8700.5**, In-House Development and Maintenance of Software Projects
- **580-PG-8730.3.1**, [Product Development Handbook](#)
- **580-PL-002-01**, [ISD Software Policies](#)

Additional guidance for this process was obtained from:

- **Glossary**: <http://software.gsfc.nasa.gov/glossary.cfm>
Defines common terms used in ISD processes
- **ETVX Diagram**: Link to the ETVX diagram for this process.
- **Process Asset Library**: <http://software.gsfc.nasa.gov/process.cfm>
Library of all ISD process descriptions
- **NASA-STD-8739.3 (draft)**, Standard for Software Assurance
- **Capability Maturity Model® Integration (CMMI)**, Carnegie Mellon Software Engineering Institute, March 2002.

Check the Process Asset Library at <http://software.gsfc.nasa.gov/process.cfm> to obtain the latest version.

NOTE: Words or phrases shown in [blue underlined](#) contain links to additional information.

Guidance & tailoring information is shown in *italics with gray background*.

**Quality
Management
System Records**

Controlled Document / Description	Record Custodian
Software Measurement Plan – Although it may be published separately, this plan is usually included within the SMP/PP. The SMP/PP is a controlled document; see <u>ISD Project Monitoring and Control</u> .	Product Development Lead

Change History

Version	Date	Description of Improvements
1.0	12/05/05	Initial CCB approval